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Effects of Food Safety Education on Food Choice, Food Safety Knowledge and Practices among Students in Higher Institutions in Cross River State, Nigeria

Chinenye Blessing Onyekwelu (neneomuna@gmail.com)[1], **Philip Bassey Etabee** (pembassey@yahoo.com)[1], **Joseph Ajah Efut** (ushumolog@gmail.com)[1], Corresponding Author
Regina Ejemot-Nwadiaro (r.ejemot_nwadiaro@unical.edu.ng)[1,2], and **Promise Iwara** (promiseiwara@gmail.com)[1]
1. Department of Public Health, University of Calabar, Nigeria
2. Kampala International University, Uganda

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Abstract: *Safe food is essential for good health and disease prevention. However, unsafe food contributes to a cycle of disease, with the World Health Organization estimating 420,000 annual deaths and the loss of 33 million Disability-Adjusted Life Years (DALYs) globally. This study evaluates the impact of food safety education on university students in Cross River State, Nigeria, using a Quasi-experimental study design. The objective is to enhance students' understanding of food safety principles, influencing their dietary decisions and practices. A pretested semi-structured questionnaire was used to assess knowledge and self- reported practices at baseline and post-intervention. Data were analyzed with SPSS (version 25.0). Results show a significant improvement in food safety knowledge and practices among the intervention group compared to the control group. Pre-intervention, there was no significant relationship between knowledge and practice ($\chi^2 = 0.755$, $p = 0.385$). Post-intervention, this relationship became significant ($\chi^2 = 9.374$, $p = 0.002$), with a marked increase in mean performance scores in the intervention group. Findings indicate a positive effect of structured food safety education on participants, supporting the integration of food safety programs into university curricula. The results demonstrate the potential of targeted educational interventions to bridge knowledge gaps, promote healthier behaviors, and advocate for informed food choices among students, ultimately reducing public health risks.*

Keywords: Cross River State, Food Choice, Food Safety Education, Food Safety Knowledge, Public Health Risks

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1. Introduction

Food poisoning caused by consuming unsafe food poses a significant threat to global health, compromising human well-being and safety. Food safety is crucial for food security and is a priority from both public health and economic perspectives (United Nations, 2020). It remains a barrier to socio-economic development and the achievement of SDGs 1 and 3 (Oduori et al., 2022). Globally, food safety is a critical issue, burdened with recurrent foodborne infections that impose significant economic and social costs on societies and health systems (Insfran-Rivarola et al., 2020; Rossvoll, 2013). In developing countries, including Nigeria, foodborne illnesses are of particular concern (Onyeaka et al., 2021).

The CDC (2023) estimates that foodborne illnesses affect 48 million people annually in the U.S., leading to 128,000 hospitalizations and 3,000 deaths. Worldwide, acute gastroenteritis from contaminated food and water causes 1.6 million deaths annually, with over 33% of the U.S. population at risk (Nazrul et al., 2022). In Europe, foodborne illnesses account for 76 million cases, 325,000 hospitalizations, and 5,000 deaths yearly (Angolo, 2011). Among students, the annual prevalence rate is 16.66%, with 56,000 hospitalizations and 1,300 deaths (Brooke, 2019).

In underdeveloped countries, foodborne diseases affect over 33% of the population, aligning with WHO findings that Africa bears the highest burden globally (Ahmed et al., 2021). Schools are significant contributors to foodborne outbreaks, as poor food safety education, knowledge, and practices remain prevalent (Adjei & Adjei, 2022; Azanaw et al., 2021).

This study examines the effect of food safety education on food choices, knowledge, and practices among students in higher institutions in Cross River State, Nigeria.

2. Materials and Methods

Study Design: The study design was a Quasi-experimental design that assessed the effect of food safety education on food safety knowledge and practices and food choice of students in the study area.

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Phase I: Quantitative Survey

This phase adopted a cross-sectional descriptive study design in selection of higher institutions and students, in which questionnaires were distributed to the respondents in order to obtain baseline data on knowledge of food safety, self-reported food safety practices use of food label in making food choices and factors influencing food choices.

Phase II

Phase II of the study involved the intervention phase, where the two selected institutions was divided into intervention and control group. One institution for intervention and the other for control. Students from the intervention group were organized into clusters to receive food safety education. The WHO training manual on food safety was utilized to enhance participants' knowledge of food safety and practices. Additionally, the study incorporated the *Handbook on Food Labeling to Protect Consumers* by the Food and Agriculture Organization of the United Nations to improve participants' understanding of food labelling and its application in making informed food choices. Students in the intervention group were grouped to receive the intervention in form of food safety education and food labelling education in a classroom setting.

The intervention was delivered for three sessions lasting about 55mins to an hour using PowerPoint presentations, posters, pamphlets, and flyers. After eight weeks, the baseline questionnaire was re-administered to both the intervention and control groups. This allowed for comparisons and provided insights into the impact of food safety education on participants' knowledge of food safety, food labelling, and food safety practices within the study area.

Study Population: The study population consisted of students in tertiary institutions in Cross River State, Nigeria.

Ethical Considerations: From the Department of Public Health, University of Cala bar, Cala bar, a letter of introduction was obtained which enabled the investigator to obtain certificate of ethical approval from the Cross River State Health Research Ethics Committee, Ministry of Health. Full Ethical approval was obtained from the Cross River State Ministry of Health Research Ethics and Review Committee with REC NO: CRSMOH/HRP/REC/2023/511. Informed verbal consent was obtained from the participants who were assured of anonymity and confidentiality and given the opportunity to enable them make informed decision. Participants in the study were free from coercion, as they participated very voluntarily. The researcher told the participants that there were very free to withdraw participation at any time of the study without negatively impacting on their participation in future study or the current study.

Inclusion Criteria

- Undergraduate students (both gender) enrolled in the selected universities from different majors of study
- Provision of informed consent to participate in the study
- Willingness to stay in the study area for the entire duration of the study.

Exclusion Criteria

- Other personnel in the selected higher institutions under study such as lecturers and non-academic staff.
- Postgraduate students
- Students who refused to give consent to partake in the study.

Sample Size Determination

The sample size for the study was calculated using the formula for sample size calculation for a quasi-experimental study by Nkem (2024).

$$n = \frac{2(Z_{\alpha/2}+Z_{\beta})^2\sigma^2}{d^2}$$

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Where:

n = sample size for each arm

$Z_{\alpha/2}$ = Z score at 95% confidence level = 1.96, α =0.05

Z_{β} = Power of the test at 80% =0.84,

σ = estimated standard deviation, (4.1 from pilot study)

d= effect size (0.8 for large effect)

$$n = \frac{2 \times (1.96+0.84)^2.4.1^2}{(0.8^2)}$$

$$n = \frac{2 \times (2.8)^2.4.1^2}{(0.8^2)}$$

$$n = \frac{2 \times (7.84) \times 16.81}{(0.64)}$$

$$n = \frac{263.5808}{0.64}$$

n = 411.845, Approximately, n = 412

Adding 10% to account for non-response

$$n \text{ (number to enroll)} = \frac{\text{desired sample size}}{\text{non-response rate}} = \frac{412}{1-\text{non-response rate}} = \frac{412}{0.90} = 457.77$$

Approximately, N = 916 (458 for intervention group and 458 for control group)

Sampling Procedure

Multistage sampling technique was employed in this study for the selection of institutions, faculties, departments, levels of study and students/respondents in Cross River State, Nigeria.

Stage 1: Selection of Institutions

The two government owned universities in the State; University of Cala bar (UNICAL) and University of Cross River State (UNICROSS) were purposely selected for the study.

Stage 2: Selection of Faculties

In each selected institution, four faculties were selected using simple random sampling technique. A list of all the faculties in each selected institution was made, and numbers were assigned to the faculties. The numbers were then written on pieces of paper, folded and thrown into a basket. The basket was shaken rigorously and four papers in each institution were picked. The faculties bearing the numbers picked were selected for the study. So, a total of (2x4), that is 8 faculties were selected.

Stage 3: Selection of Departments

In each of the selected faculties, random sampling technique was used in the selection of two (2) departments, making a total of 8 departments for each selected institution.

Stage 4: Selection of Participants

The Review of Contemporary Scientific and Academic Studies
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In each selected department, using a sampling frame via proportionate sampling technique, participants were chosen by selecting student groups based on their year of study so that participants involved in this research were chosen from their levels of study that were sample representative of the sample size.

Instruments for Data Collection

The questionnaire used in this study to assess food safety knowledge, food labelling awareness, food safety practices, and factors influencing food choices among university students was developed by integrating questions from updated, valid, and reliable instruments from previous research (Adjei & Adjei, 2022; Nazrul et al., 2022; Azanaw et al., 2021; Kayode, 2021; Imath iu, 2020; Brooke, 2019). This structured questionnaire also gathered information on the socio-demographic characteristics of the respondents.

Allocation

This simply means allocation to different groups, in such a way that there is equal right of being allocated to any of the groups. For this study, the selected universities were randomly allocated to either the control group or the intervention group. The students in the intervention were assigned to student groups (clusters) to receive the education in their lecture halls.

Intervention

The intervention aimed to equip the participating students with knowledge about food safety, food labelling, and proper food safety practices, empowering them to make informed dietary choices and proactively prevent foodborne illnesses. The strategy involved a structured food safety and labelling education program, delivered to groups within the intervention cohort. This program was implemented in three phases, spaced one week apart, following the WHO's food safety education guide and the FAO's *Handbook on Food Labeling to Protect Consumers*. Participants attended three (one-hour) food safety education sessions over a eight-week period. Four weeks after the intervention, a reassessment was conducted using the same instrument administered at baseline. Notably, the control group did not receive any intervention.

The content of the education sessions adhered strictly to the WHO's guidelines on food safety practices and the FAO's handbook on food labelling. Key topics included the WHO's five basic principles of food safety and techniques for reading and interpreting food and nutrition labels. The sessions were interactive, addressing participants' questions and concerns comprehensively. Participants were also provided with fliers summarizing the "Five Keys to Food Safety" and essential elements to consider on food labels. They were encouraged to implement the knowledge gained from the sessions to gradually adopt healthier and safer food habits.

The Food Safety Education Guide

The food safety education guide was based on the WHO manual for food safety training, covering the "Five Keys to Safer Food." A complementary food labelling guide was adapted from the FAO of the United Nations (Sections 1, 6, and 7), focused on key topics such as basic concepts of food labelling, the components of a food label, and interpreting nutrition information on packaged products. Power Point presentations enriched with visual illustrations was employed to effectively communicate these topics. The training was divided into three sessions, culminating in demonstrations on fundamental food safety principles and label interpretation, where students practiced and showcased their understanding through interactive activities.

Validation of Data Collection Instrument

To ensure validity, the research instruments were adapted from items in the Food Safety Awareness questionnaire (Adjei & Adjei, 2022; Lee et al., 2016; Angolo, 2011; Imath iu, 2020) and the Hazard Analysis and Critical Control Point (HACCP) guidelines (Brooke, 2019; Nazrul *et al.,* 2022; Azanaw *et al.,* 2021; Kayode, 2021). The tools were then modified to align with the specific objectives of the study under the supervision and guidance of the research advisor.

Reliability of Data Collection Instrument

The reliability of the research instruments was tested using Cronbach's alpha coefficient in SPSS. Each item was analyzed to identify any that show low correlation with the overall scale score. The reliability coefficient for food safety practices, as a dependent variable, was calculated and compared against

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established benchmarks. According to George & Mallery (2003), a Cronbach's alpha value greater than 0.70 reflects good internal consistency. The resulting reliability scores helped confirm whether the scales used in this study met acceptable standards and comparable to those in previous studies (George & Mallery, 2003; Angolo, 2011).

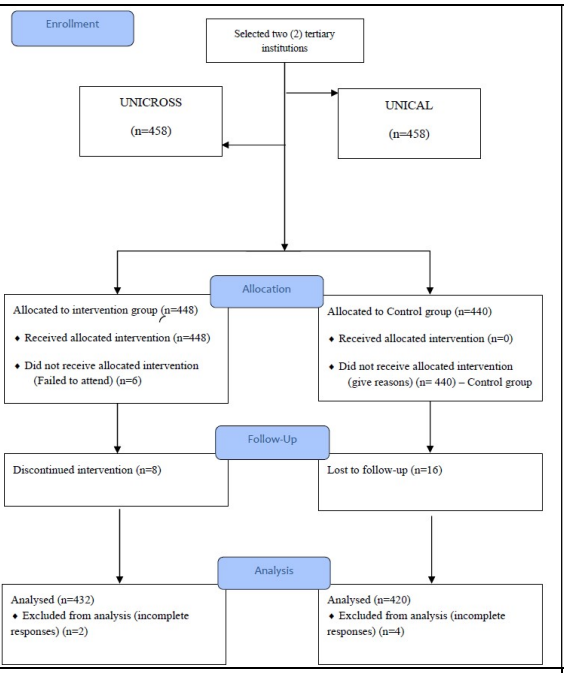

Figure 1: Study flow chart

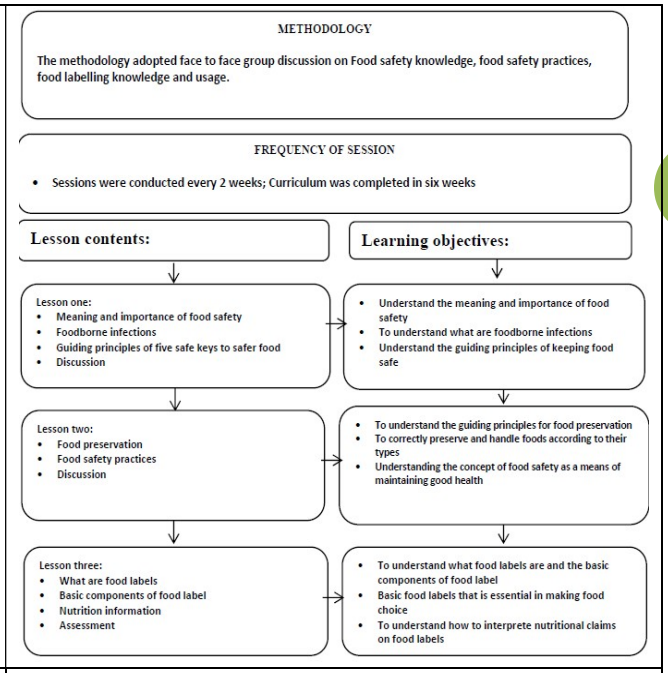

Figure 2: Objectives and contents of food safety education

Method of Data Collection Procedure

Three research assistants with tertiary education qualifications were recruited and trained during the pre-test phase to assist with data collection. After employing multistage sampling to identify the study participants, informed consent was obtained, and the purpose of the research was thoroughly explained to all participants before data collection begins. The semi-structured questionnaires were administered to students in their lecture halls, where the researcher and assistants waited to collect the completed forms. This procedure was repeated during the post-intervention phase. Insights from previous studies of a similar nature (Adjei & Adjei, 2022; Lee et al., 2016; Angolo, 2011; Imath iu, 2020; Nazrul et al., 2022; Fasoro et al., 2016; Brooke, 2019) were drawn upon to guide the process.

Study Variables

Independent variable: The provision of food safety education, focusing on its impact on food safety practices and outcomes, as well as demographic factors.

Dependent Variable: Levels of knowledge about food safety, food labelling, and food safety practices.

Primary outcome measures: Improvement in knowledge of food safety, understanding of food labelling, and adoption of proper food safety practices, measured during the baseline survey and reassessed after the intervention.

Method of Data Analysis

The raw data was first meticulously reviewed to identify and correct errors before being cleaned and entered into Microsoft Excel. It was then exported to SPSS (version 25) for analysis. Descriptive statistics, including means, frequencies, and standard deviations, were computed to summarize the data and profile the demographic characteristics of the participants.

Independent t tests evaluated differences in demographic characteristics. One Way ANOVA determined variations in food safety knowledge and handling practices among different groups. Pearson correlation measured the relationships between variables. Chi Square tests and Logistic regression analyses assessed

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www.thercsas.com
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associations and test study hypotheses. To strengthen the findings, self-reported outcomes from participants were triangulated with observed food choices and safety practices, ensuring robust analysis of relationships and associations within the data.

3. Results

Socio-Demographic Characteristics of Respondents

It can be observed from the findings that the number of male respondents in the two Universities was higher than that of female respondents with UNICAL having 252 (60%) male respondents and UNICROSS having 232 (53.6%) of the respondents. The findings further revealed that majority of the students were in the age category of 20-29 years (UNICAL; 228 (54.3%) and UNICROSS 326 (75.5%) of the respondents. Considering respondents' marital status, it was revealed that most of the respondents in the two universities were single with, 402 (93%) single participants in UNICROSS and 334(79.5%) in UNICAL. Regarding the household size of the respondents, it was shown that more than 338 (78.2%) of the respondents were from a household with 1-4 persons (size) in UNICROSS and UNICAL the number was slightly lower with a household size of 269 (64.0%) of the respondents. It was also evident that 190 (44%) of the respondents in UNICROSS were living off-campus, and 218(52%) in UNICAL. Four (4) faculties each were included in the study in both institutions, two (2) departments in each faculty making a total of eight (8) departments for each institution (Table 1).

It was affirmed by 79 (18.3%) of the respondents in UNICROSS that they have received training or education on food safety, compared to the responses of 68 (16.2%) respondents in UNICAL. Conversely, 353 (81.7%) at UNICROSS and 352 (83.8%) at UNICAL reported not having received such training. Regarding been employed in the food service industry, 374 (86.6%) of respondents at UNICROSS and 388 (92.4%) at UNICAL stated they had never been employed in the sector. Lastly, the frequency of food preparation for others was primarily daily, as reported by 249 (57.6%) of respondents at UNICROSS and 283 (67.1%) at UNICAL.

Table 1: Faculties & Departments of respondents in UNICAL (N=420) and UNICROSS (N=432)

FACULTY UNICAL	N	%	FACULTY UNICROSS	N	%
Biological Sciences	102	24.3	Engineering	110	25.5
Physical Sciences	108	25.7	Environmental Sciences	107	24.8
Vocational & Science Education	98	23.3	Physical Science	109	25.2
Arts & Social Science Education	112	26.7	Education	106	24.5
Total	420	100.0		432	100.0

UNICAL DEPARTMENTS	**N**	**%**	**UNICROSS DEPARTMENTS**	**N**	**%**
Genetics and Biotechnology	49	11.7	Civil Engineering	54	12.5
Microbiology	53	12.6	Mechanical Engineering	56	13.0
Pure and Applied Chemistry	55	13.1	Estate Management	53	12.3
Computer Science	53	12.6	Urban and Regional Planning	54	12.5
Human Kinetics	51	12.1	Biochemistry	57	13.2
Science Education	47	11.2	Statistics	52	12.0
Guidance and Counselling	55	13.1	Library and Information Science	51	11.8
Social Science Education	57	13.6	Education foundation and Administration	55	12.7
Total	**420**	**100.0**	**Total**	**432**	**100.0**

Table 2: Socio-Demographical Characterization

Sociodemographic data	**Frequency**		**Percentage (%)**	
Gender	**UNICROSS (n=432)**	**UNICAL (n=420)**	**UNICROSS (n=432)**	**UNICAL (n=420)**
Male	232	168	53.7	40.0
Female	200	252	46.3	60.0
Age				
10-19	88	120	20.4	28.6
20-29	326	228	75.5	54.3

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An International Multidisciplinary Online Journal
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30-39	18	72	4.1	17.1
Marital Status				
Single	402	334	93.0	79.5
Married	28	86	6.5	20.5
Widowed	2	-	0.5	-
Household size				
1-4	338	269	78.2	64.0
5-8	60	123	13.9	29.3
9 -12	24	24	5.6	5.7
>=13	10	4	2.3	1.0
Place of residence				
Family house	130	80	30.1	19.0
Hostel	112	122	25.9	29.0
Off campus	190	218	44.0	52.0
Received training/education on food safety				
Yes	79	68	18.3	16.2
No	353	352	81.7	83.8
Have been employed in food service industry				
Yes	58	32	13.4	7.6
No	374	388	86.6	92.4
Frequency of food preparation for others				
Daily	249	282	57.6	67.1
Never	40	52	9.3	12.4
Weekly	45	18	10.4	4.3
Monthly	98	68	22.7	16.2

Knowledge of Food Safety Measures

Considering the results, it is evident that the intervention group mean performance was slightly higher during the pre-test than the mean score for the control group. This is belief to be based on chance not because of the influence of the treatment that was yet to be administered to the intervention group. However, after the administration of the treatment, the intervention group outperformed the control group by a very large margin in the area of respondents' knowledge on food safety measures as a tool for addressing the knowledge gap in the study areas which was signified by the mean score (χ^2 = 74.42) that was far higher than the control group mean score (χ^2 = 21.01). The rise in the performance of the intervention group as can be observed in their increase in scores cannot only be attributed to chance; but it is ascertained to as a matter of fact be based on the effect of the treatment that was administered to the intervention group in terms of food safety training activities for six weeks. However, the increase found among the control group respondents' (χ^2 = 21.01, SD=1.455) when the post test was administered can be attributed to chance and not due to the same treatment that was given to the intervention group. The increase in control group scores could be as a result of their interaction with members of their university communities, families, friends, internet or from other media sources after being exposed to the first week pre-test questions administration in their location.

It is clearly evident that the effect of such exposure by the control group cannot be compared to the exposure to the food safety training activities that was experienced by the intervention group who were part of treatment for six weeks. The summary of the analysis of a one-way ANOVA conducted to examine the effect of the treatment on research subjects between the post-test and pretest scores between the intervention and control groups shows a statistically significant difference between the intervention and control groups scores of the respondents, F for Pretest (413.177, p=0.0001) and F for Post-test (26119.772, p=0.0001). With table 2 showing that the interaction of the treatment with the intervention group scores signifies F ratio (F = 26,119.772; P= 0.0001) for intervention group scores was also strongly significant, this is because the F ratio of 26,119.772 was found to be by far higher than the critical value F=3.86. Carefully examining table 3, it can be seen that there is connection between students' exposure to training on food safety measures for eight weeks and the rise in their score during the post-test for the intervention group indicating that the post test scores and treatment have a statistically significant positive relationship (r=.568, P= 0.0001). The reason for this assertion is because the calculated P-value of 0.0001 is less than the tabulated or critical P<0.05.

Food Safety Practice

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
www.thercsas.com
ISSN: 2583-1380 Vol. 5 | Issue No. 02 | February 2025 Impact Factor: 6.53

Pertaining to the result presented in Table 3, it is obvious that the intervention group mean performance was again higher during the pre-test than the mean score for the control group. This is also believed to be due to chance not because of the influence of any treatment that was yet to be administered to the intervention group. However, after the administration of the treatment, the intervention group again outperformed the control group by a very large margin with respect to the respondents' food safety practice as a tool for addressing the knowledge gap in the study areas which was signified by the mean score ($\chi^2 = 28.81$) that was higher than that of the control group mean score ($\chi^2 = 19.72$). The sudden improvement in the performance of the intervention group as can be seen in their very high scores cannot be attributed to chance; but it is an indication of the effect of the treatment that was administered to the intervention group in terms of food safety training activities for six weeks. However, the increase found among the control group respondents' ($\chi^2 = 19.72$, SD=2,797) when the post test was administered can be attributed to chance and not due to the same treatment that was given to the intervention group. The increase in control group scores may be as a result of their interaction with members of the University communities, families, friends, internet or from other media sources after being exposed to the first week pre-test questions administration in their university.

It is clearly evident that the effect of such exposure by the control group cannot be compared to the exposure to the food safety training activities that was experienced by the intervention group who were part of treatment for six weeks. Furthermore, the summary of the analysis of a one-way ANOVA in Table 3 conducted was to determine the impact of the treatment on research subjects during the post-test and pretest for the intervention and control groups. Findings illustrated shows a statistically significant difference between the intervention and control groups pretest and post-test scores of the respondents, F for Pretest (762.720, p=0.0001) and F for post-test (1980.689, p=0.0001). The interaction of the treatment with the intervention group scores signifies F ratio (F = 1980.689; P= 0.0001) for the intervention group post-test scores was also strongly significant, this is because the F ratio of 1980.689 was found to be by far greater than the critical value F=3.86. In addition, critical look at the correlation outcome of the post-test scores between groups shows a strong positive relationship between the treatment administered and the performance of the intervention group after the treatment was administered (r=.588, P= 0.0001). It can be deduced from the result that there is an association between students' exposure to training on food safety practices and the treatment the intervention group were exposed to for six weeks and the increase in their score during the post-test for the intervention group indicated that the post test scores and treatment have a strong positive statistically significant relationship. The reason for this conclusion is because the calculated P-value of 0.0001 is less than the tabulated or critical P<0.05.

Table 3: Summary of analysis of Mean, Standard Deviation, Frequency, One-way ANOVA and Correlation on respondents' food safety practice among students in UNICAL and UNICROSS in Cross River State

Descriptives									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Pretest Food Safety Practice	Intervention Group	432	10.88	3.717	.179	10.53	11.23	0	20
	Control Group	420	4.30	3.216	.157	3.99	4.60	0	17
	Total	**852**	**7.63**	**4.790**	**.164**	**7.31**	**7.96**	**0**	**20**
Post-test Food Safety Practice	Intervention Group	432	28.81	3.144	.151	28.51	29.10	19	35
	Control Group	420	19.72	2.797	.136	19.46	19.99	16	24
	Total	**852**	**24.33**	**5.431**	**.186**	**23.96**	**24.69**	**16**	**35**

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
Pretest Food Safety Practice	Between Groups	9232.615	1	9232.615	762.720	.000
	Within Groups	10289.131	850	12.105		
	Total	**19521.746**	**851**			
Post-test Food Safety Practice	Between Groups	17564.353	1	17564.353	1980.689	.000
	Within Groups	7537.629	850	8.868		
	Total	**25101.981**	**851**			

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
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ISSN: 2583-1380 Vol. 5 | Issue No. 02 | February 2025 Impact Factor: 6.53

Correlations				
		Group	Pretest Food Safety Practice	Post-test Food Safety Practice
Pretest Food Safety Practice	Pearson Correlation	-.688**	1	.588**
	Sig. (2-tailed)	.000		.000
	Sum of Squares and Cross-products	-1402.197	19623.332	13026.535
	Covariance	-1.648	22.739	15.307
	N	**852**	**864**	**852**
Post-test Food Safety Practice	Pearson Correlation	-.836**	.588**	1
	Sig. (2-tailed)	.000	.000	
	Sum of Squares and Cross-products	-1934.028	13026.535	25101.981
	Covariance	-2.273	15.307	29.497
	N	**852**	**852**	**852**
**. Correlation is significant at the 0.01 level (2-tailed).				

Food Label Knowledge

Regarding the result presented in Table 4; it can be seen that the intervention group mean performance was lower (χ^2 = 24.23±7.552) during the pre-test than the mean score for the control group (χ^2 = 26.16±7.443). This is also viewed to be based on chance not necessarily due to the influence of any treatment (training or education on food safety) that was yet to be administered to the intervention group. However, after the treatment was administered, the intervention group outperformed the control group by a very large margin with regards to the respondents' food label knowledge as a tool for addressing the knowledge gap in the university which was indicated by the mean score (χ^2 = 68.72±7.502) that was far higher than the control group mean score (χ^2 = 48.73±6.654). The average mean post-test score (χ^2 = 58.87±12.262) for food label knowledge was also observed to be far greater than that of the average pretest mean score (χ^2 = 25.18±7.556). The sudden surge seen in the performance of the intervention group as can be observed in their very high scores cannot be attributed to chance; but it is as a result of the effect of the treatment that was administered to the intervention group in terms of food safety training activities for six weeks. However, the increase found among the control group respondents' (χ^2 = 48.73, SD=6.654) when the post test was administered can be attributed to chance and not due to the same treatment that was given to the intervention group. The rise in control group scores may be attributed to their interaction with members of the University communities, families, friends, internet or from other media sources after being exposed to the first week pre-test questions administration in their university.

It is obviously affirmed that the effect of such exposure by the control group cannot be compared to the exposure to the food safety training activities that was experienced by the intervention group who were part of treatment conducted for eight weeks. The result of the analysis of the one-way ANOVA in Table 4 carried out to examine the effect of the treatment on research subjects during the post-test and pretest for the intervention and control groups, shows that there was a statistically significant difference between the intervention and control groups pretest and post-test scores of the respondents, with F for Pretest (14.181, p=0.0001) and F for post-test (1690.647, p=0.0001). The interaction of the treatment with the intervention group scores signifies F ratio (F = 1690.647, p=0.0001) for the intervention group post-test scores was also strongly significant, this is because the F ratio of 1690.647 was discovered to significantly surpass the critical value F=3.86. In addition, critical look at the correlation outcome of the post-test scores between groups shows a strong positive relationship between the treatment administered and the performance of the intervention group after the treatment was administered (r=.128, P= 0.0001). It can be said from the outcome that there is a relationship between students' exposure to training on food safety and the treatment the intervention group were exposed to for four weeks led to the increase observed in their score during the post-test for the intervention group indicating that the post-test scores and treatment have a strong positive statistically significant relationship. The reason for this being that the calculated P-value of 0.0001 is less than the tabulated or critical P<0.05.

Table 4: Summary of analysis of Mean, Standard Deviation, Frequency, One-way ANOVA and Correlation on respondents' food label knowledge among students in UNICAL and UNICROSS in Cross River State

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
www.thercsas.com
ISSN: 2583-1380 Vol. 5 | Issue No. 02 | February 2025 Impact Factor: 6.53

Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Pretest Food Label knowledge	Intervention Group	432	24.23	7.552	.363	23.51	24.94	6	39
	Control Group	420	26.16	7.443	.363	25.45	26.88	0	37
	Total	**852**	**25.18**	**7.556**	**.259**	**24.67**	**25.69**	**0**	**39**
Post-test Food Label knowledge	Intervention Group	432	68.72	7.502	.361	68.01	69.43	50	85
	Control Group	420	48.73	6.654	.325	48.09	49.36	40	64
	Total	**852**	**58.87**	**12.262**	**.420**	**58.04**	**59.69**	**40**	**85**

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
Pretest Food Label knowledge	Between Groups	797.405	1	797.405	14.181	.000
	Within Groups	47794.759	850	56.229		
	Total	**48592.164**	**851**			
Post-test Food Label knowledge	Between Groups	85149.299	1	85149.299	1690.647	.000
	Within Groups	42810.179	850	50.365		
	Total	**127959.478**	**851**			

Correlations

		Group	Pretest Food Label Knowledge	Post-test Food Label Knowledge
Pretest Food Label Knowledge	Pearson Correlation	.128**	1	-.114**
	Sig. (2-tailed)	.000		.001
	The sum of Squares and Cross-products	412.085	48592.164	-8954.214
	Covariance	.484	57.100	-10.522
	N	**852**	**852**	**852**
Post-test Food Label Knowledge	Pearson Correlation	-.816**	-.114**	1
	Sig. (2-tailed)	.000	.001	
	The sum of Squares and Cross-products	-4258.310	-8954.214	127959.478
	Covariance	-5.004	-10.522	150.364
	N	**852**	**852**	**852**

****. Correlation is significant at the 0.01 level (2-tailed).**

Food Label Knowledge Information Use by Respondents

Considering result presented in Table 5; the intervention group mean score performance was higher (χ^2 = 14.13±2.991) during the pre-test than the mean score for the control group (χ^2 = 7.06±3.094). This is believed to be based on chance not necessarily because of the impact of any treatment (training or education on food safety) which was not yet administered to the intervention group. Nevertheless, after the treatment administration, the intervention group outperformed the control group by an overwhelming score margin with regards to the respondents' food label knowledge information use as a tool for addressing the knowledge gap in the university which was indicated by the mean score (χ^2 = 35.54±5.975) that was greater than the control group mean score (χ^2 = 24.09±4.807). The average mean post-test score (χ^2 = 29.90±7.894) for food label knowledge information use was also seen to be far greater than that of the average pretest mean score (χ^2 = 10.64±4.664). The increase observed in the performance of the intervention group as can be seen in their very high scores cannot be said to be due to chance alone; but it is as a result of the influence of the treatment that was administered to the intervention group in regards to food safety training and education activities for eight weeks. On the other hand, the increase observed among the control group respondents' (χ^2 = 24.09, SD=4.807) when the post test was administered can be attributed to chance and not because of the same treatment that was given to the intervention group. The rise in control group scores may be linked to their interaction with members of the University communities, families, friends, guesses, internet or from other media sources after being exposed to the first week pre-test questions administration in their university.

It is evident that the impact of such exposure by the control group cannot be compared in any way to the exposure to the food safety training and activities that was experienced by the intervention group who were

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
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ISSN: 2583-1380 Vol. 5 | Issue No. 02 | February 2025 Impact Factor: 6.53

part of treatment conducted for eight weeks. The result of the analysis of the one-way ANOVA in Table 6 employed to examine the effect of the treatment on research participants during the post-test and pretest for the intervention and control groups, shows that there was a statistically significant difference between the intervention and control groups pretest and post-test scores of the respondents, with F for Pretest (947.970, p=0.0001) and F for Post-test (1150.220, p=0.0001). The interaction of the treatment with the intervention group scores signifies F ratio (F = 1150.220, p=0.0001), for the intervention group post-test scores was also strongly significant, this is because the F ratio of 1150.220 was found to be by far larger than the critical value F=3.86. Likewise, a critical observation of the correlation table result of the post-test scores between groups shows a strong positive relationship between the treatment administered and the performance of the intervention group after the treatment was administered (r=.573, P= 0.0001). The result attest that there is a relationship between students' exposure to food label information use and the treatment the intervention group received for eight weeks leading to the increase found in their score during the post-test for the intervention group, thus indicating that the post-test scores and treatment have a strong positive statistically significant relationship. The reason for this is because, the calculated P-value of 0.0001 is less than the tabulated or critical P<0.05.

Table 5: Summary of analysis of Mean, Standard Deviation, Frequency, One-way ANOVA and Correlation on respondents' food label knowledge use among students in UNICAL and UNICROSS in Cross River State

Descriptives									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Post-test Food Label Knowledge Use	Intervention Group	432	35.54	5.975	.287	34.98	36.11	24	53
	Control Group	420	24.09	4.807	.235	23.62	24.55	18	36
	Total	**852**	**29.90**	**7.894**	**.270**	**29.36**	**30.43**	**18**	**53**
Pretest Food Label Knowledge Use	Intervention Group	432	14.13	2.991	.144	13.84	14.41	6	21
	Control Group	420	7.06	3.094	.151	6.76	7.35	0	19
	Total	**852**	**10.64**	**4.664**	**.160**	**10.33**	**10.96**	**0**	**21**

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Post-test Food Label Knowledge Use	Between Groups	27959.624	1	27959.624	947.970	.000
	Within Groups	25070.079	850	29.494		
	Total	53029.703	851			
Pretest Food Label Knowledge Use	Between Groups	10645.189	1	10645.189	1150.228	.000
	Within Groups	7866.626	850	9.255		
	Total	18511.816	851			

Correlations			
		Post-test Food Label knowledge use	Pretest Food Label knowledge use
Post-test Food Label Knowledge on Usage	Pearson Correlation	1	.573**
	Sig. (2-tailed)		.000
	The sum of Squares and Cross-products	53029.703	17954.140
	Covariance	62.315	21.098
	N	**852**	**852**
Pretest Food Label knowledge on Usage	Pearson Correlation	.573**	1
	Sig. (2-tailed)	.000	
	The sum of Squares and Cross-products	17954.140	18511.816
	Covariance	21.098	21.753
	N	**852**	**852**

****. Correlation is significant at the 0.01 level (2-tailed).**

Factors Influencing Respondents' Food Choice

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
www.thercsas.com
ISSN: 2583-1380 Vol. 5 | Issue No. 02 | February 2025 Impact Factor: 6.53

When factors influencing respondents' food choice was evaluated, the outcome in Table 6 indicated that; the intervention group mean score performance was again higher (χ^2 = 19.99±3.920) during the pre-test than the mean score for the control group (χ^2 = 14.17±3.498). This is considered to be based on chance not necessarily because of the impact of any treatment (training or education on food safety) which was not yet administered to the intervention group. That notwithstanding, after the administration of the treatment, the intervention group outperformed the control group by a wide score margin regarding factors influencing food choice among respondents as a tool for addressing the knowledge gap in the university indicated by a mean score of (χ^2 = 37.91±2.495) that was higher than the control group mean score of (χ^2 = 16.60±2.214). Similarly, the average mean post-test score of (χ^2 =27.40±10.920) for factors influencing food choice was also seen to be far larger than that of the average pretest mean score (χ^2 = 17.12±4.721). The increment in post-test scores as can be seen in the performance of the intervention group cannot be claimed to be based on chance alone; but can be ascribed to the influence of the treatment that was provided to the intervention group in respect to the food safety training and education activities for eight weeks. Contrarily, the increase observed among the control group respondents' (χ^2 = 17.12±4.721) when the post test was provided can be attributed to chance and not because of similar treatment that was provided to the intervention group. The increase in control group scores may be connected to their interaction with members of the University communities, members of their families, friends, neighbors, internet, media or from other sources after being exposed to the first week pre-test questions administration in their university.

It is evident that the effect of such exposure by the control group cannot be compared in any way to the exposure to the food safety training and activities that was experienced by the intervention group who took part in treatment conducted for eight weeks. The result of the analysis of the one-way ANOVA in Table 7 used to determine the effect of the treatment on study participants when the post-test and pretest was administered to the intervention and control groups, the result revealed that there was a statistically significant difference between the intervention and control groups pretest and post-test scores of the respondents, with F for Pretest scores (521.624, p=0.0001) and F for post-test scores (17361.567, p=0.0001). The interaction of the treatment with the intervention group scores signifies F ratio of (17361.567, p=0.0001) for the intervention group post-test scores was also strongly significant, this is because the F ratio of 17361.567was found to be by far larger than the critical value F=3.86. More so, a critical observation of the correlation table result of the post-test scores between groups shows a strong positive relationship between the treatment administered and the performance of the intervention group after the treatment was administered (r=.595, P= 0.0001). The result affirmed that there is a relationship between students' exposure to factors influencing food choices by the respondents and the treatment the intervention group received to for four weeks resulting in the increase observed in their score during the post-test for the intervention group indicating that the post-test scores and treatment have a strong positive statistically significant relationship. The reason for this being that the calculated P-value of 0.0001 is less than the tabulated or critical P<0.05.

Table 6: Summary of analysis of Mean, Standard Deviation, Frequency, One-way ANOVA and Correlation on respondents' view on factors influencing food choice among students in UNICAL and UNICROSS in Cross River State

ANOVA						
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Pretest Factor Influencing Food Choice	Between Groups	7211.685	1	7211.685	521.624	.000
	Within Groups	11751.620	850	13.825		
	Total	**18963.305**	**851**			
Post-test Factors Influencing Food Choice	Between Groups	96748.245	1	96748.245	17361.567	.000
	Within Groups	4736.670	850	5.573		
	Total	**101484.914**	**851**			

Correlations				
		Group	**Pretest Factor Influencing Food Choice**	**Post-test Factors Influencing Food Choice**
Pretest Factor Influencing Food Choice	Pearson Correlation	-.617**	1	.595**
	Sig. (2-tailed)	.000		.000

The Review of Contemporary Scientific and Academic Studies
An International Multidisciplinary Online Journal
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	The sum of Squares and Cross-products	-1239.268	18963.305	26093.131
	Covariance	-1.456	22.284	30.662
	N	**852**	**852**	**852**
Post-test Factors Influencing Food Choice	Pearson Correlation	-.976**	.595**	1
	Sig. (2-tailed)	.000	.000	
	The sum of Squares and Cross-products	-4539.085	26093.131	101484.914
	Covariance	-5.334	30.662	119.254
	N	**852**	**852**	**852**

**. Correlation is significant at the 0.01 level (2-tailed).

Effect of food safety education on Food safety practice, food label literacy, food label knowledge information use and factors influencing food safety

The Chi-square test results demonstrated the impact of treatment (food safety education) on participants in the intervention group during the post-test evaluation. Before the intervention, the pre-test results indicated no significant relationship between knowledge and practice, with $\chi^2 = 0.755$, df = 1, p = 0.385, and an effect size (Phi and Cramer's V) of 0.042 (4.2%). However, after the intervention, the association became significant, with $\chi^2 = 9.374$, df = 1, p = 0.002, and an effect size of 0.147 (14.7%). This outcome led to the rejection of the null hypothesis and acceptance of the alternative hypothesis.

These findings align with the research by Sayuti et al. (2020), who assessed food safety knowledge, attitudes, and practices among 430 university students in Shah Alam. Their Pearson Correlation analysis showed strong positive relationships between knowledge and practice (r = 0.520), knowledge and attitude (r = 0.518), and attitude and practice (r = 0.826). Regression analysis further revealed a significant positive association between knowledge and practice (β = 0.0235, t(403) = 12.1983, p = 0.001), indicating that food safety education significantly improves knowledge and influences practices. Similarly, Lawal et al. (2023) conducted a study on food safety knowledge and practices among university students in Northern Ghana. Although not an intervention study, their findings demonstrated that knowledge significantly influenced food safety practices and compliance with proper handling procedures, with statistical significance at $p < 0.05$. In summary, these studies corroborate the conclusion that food safety education is highly effective in enhancing students' knowledge, leading to better food safety practices and improved health outcomes.

4. Discussion

This study highlights the significant impact of educational intervention on food safety knowledge, practices, and food label awareness among respondents, particularly in the intervention group. The findings demonstrated that exposing individuals to structured training significantly enhances their understanding and practical application of food safety measures, as evidenced by the remarkable mean differences in post-test scores between intervention and control groups.

The intervention group's mean post-test score for knowledge of food safety measures (74.42±6.619) was significantly higher than the control group's score (21.01±1.455), affirming the effectiveness of the four-week training. This outcome aligns with previous studies, such as that of Nazrul et al. (2022), which noted low baseline knowledge of food safety among Bangladeshi university students but emphasized the transformative effect of targeted education. Similarly, the work of Obed-Ojuchuwu in Rivers State, Nigeria, demonstrated the value of health education in enhancing food vendors' knowledge, with significant knowledge gains observed post-intervention.

In terms of food safety practices, the intervention group achieved a post-test mean score of 28.81±3.144 compared to the control group's 19.72±2.797. These results corroborate Adjei & Adjei's (2022) findings, which reported poor baseline food safety practices among students in Ghana, suggesting that education is a key strategy for improvement. Furthermore, this study's findings reflect trends observed in research by Fasoro et al. (2016), which reported good self-reported practices among rural Nigerian respondents but highlighted discrepancies between reported and observed behaviors, underscoring the importance of intervention-based studies for accurate assessment. Regarding food label knowledge, the intervention group exhibited a dramatic post-test improvement (68.72±7.502) compared to the control group (48.73±6.654).

Similarly, Sindhu and Madaiah (2023) demonstrated that adolescents' ability to utilize food label information improved significantly post-education.

This study, unlike many previous works that relied on single data collection methods (Nordhagen, 2022), combined pre- and post-test evaluations with educational intervention, providing robust evidence of the transformative power of education on food safety. The findings highlight the need for incorporating systematic training into public health initiatives to foster better food safety practices and awareness across diverse populations. These results emphasize that education remains a pivotal tool in addressing food safety challenges, as supported by various studies, including the current one.

5. Conclusion

The study concluded that food safety education significantly improves students' food safety knowledge, practices, food label use, and healthier food choices in higher institutions (UNICAL and UNICROSS) in Cross River State, Nigeria. Post-test analysis revealed that students who participated in food safety education programs showed notable improvements in understanding safe food handling, reading food labels, and making informed food choices compared to those who did not receive the intervention. These statistically significant outcomes underscore the need for structured food safety education initiatives to foster health-conscious and safety-compliant behavior among students. However, several factors such as health, convenience, price, familiarity with products, mood, weight control, and ethical concerns pose barriers to achieving consistent healthy food choices. Addressing these determinants through targeted interventions can help overcome these challenges and promote students' well-being. Stakeholders, including university authorities, parents, health professionals, and policymakers, must prioritize food safety education as a key strategy. In particular, higher education institutions like UNICAL and UNICROSS should integrate food safety education into their curricula, especially within Public Health, Nutrition, Health Sciences, and Hospitality programs. Providing students with the necessary knowledge and skills will empower them to adopt safe food practices and make informed dietary decisions. Researchers and supervisors must also actively disseminate food safety information to students, ensuring its accessibility and relevance. Such efforts will contribute to the overall health and well-being of university communities.

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- **Chinenye Blessing Onyekwelu**: Conceptualized the study, led the development of the research methodology, and oversaw data collection.
- **Philip Bassey Etabee**: Provided expertise in study design and supported in the supervision of the research process, contributed to data analysis, and assisted in drafting the manuscript.
- **Joseph Ajah Efut**: Contributed to data collection, performed statistical analyses, and contributed to manuscript writing.
- **Regina Ejemot-Nwadiaro**: Provided overall supervision of the research process, ensured ethical compliance, and reviewed the manuscript for critical intellectual content.
- **Promise Eyo Iwara**: Supported in data collection and entry.